REDUCTION OF AMMONIA IN CHICKEN MANURE USING NATURAL BIOFILM HUSK

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Abstract. Chicken manure is a source of environmental pollution due to its high ammonia content, which can cause pungent odors, degrade air quality, and negatively affect human and livestock health. Efforts to control ammonia require simple, environmentally friendly approaches that rely on local resources. This study aims to evaluate the effectiveness of natural biofilm husks in reducing ammonia levels in chicken manure. The study was conducted experimentally by comparing ammonia levels in chicken manure treated with husks (control) and in manure treated with natural biofilm husks. Ammonia levels were used as the primary parameter for evaluating treatment effectiveness. The results showed that the ammonia level in chicken manure before treatment was 1.21, and after the addition of natural biofilm husks, it decreased to 0.30, representing a 75.21% reduction. This decrease in ammonia levels is thought to be related to the activity of the natural biofilm on the husks, which functions as a habitat for microorganisms, especially nitrifying and heterotrophic bacteria and saprophytic fungi, which play a role in the assimilation and transformation of nitrogen compounds. These results indicate that natural biofilm husks have the potential to be a simple, inexpensive, and sustainable alternative technology for controlling ammonia in chicken manure waste.

Keywords: Ammonia, chicken manure, husks, natural biofilm, microorganisms

1. Introduction

Chicken farming is a strategic sector in the supply of animal protein, but it produces large amounts of manure that can potentially cause environmental pollution if not managed properly [1]. One of the main problems with chicken manure is its high ammonia content, which arises from the microbial decomposition of nitrogen compounds, especially uric acid and urea [2]. Ammonia released into the environment can cause pungent odors, degrade air quality, and negatively affect human and livestock health [3].

Ammonia emissions from livestock manure also contribute to atmospheric pollution and eutrophication of aquatic environments through nitrogen deposition [4]. Therefore, controlling ammonia from chicken manure waste is an important issue in sustainable livestock waste management [5]. Various methods have been developed to reduce ammonia levels, including chemical treatment, aeration, and the use of adsorbents, but some are costly and can cause additional environmental impacts [6].

The biological approach using lignocellulosic materials is becoming an increasingly popular alternative because it is environmentally friendly and easy to apply [7]. Rice husks are an abundant agricultural waste product in Indonesia and have a porous structure, making them a potential medium for supporting microbial growth [8]. Husk that undergoes natural biofilm formation can become a habitat for microbial communities, including saprophytic bacteria and fungi, which play a role in the assimilation and transformation of nitrogen compounds [9].

Natural biofilms are known to enhance the efficiency of biological processes through synergistic interactions among microorganisms bound within extracellular polymeric substances (EPS) [10]. Several studies have reported that nitrifying bacteria and heterotrophic microorganisms in biofilms play an important role in reducing ammonia concentrations through nitrogen oxidation and assimilation processes [11]. In addition, saprophytic fungi such as Aspergillus, Penicillium, and Trichoderma have been reported to utilize inorganic nitrogen for biomass growth [12].

Although the potential of natural biofilm husks is considerable, studies on their direct use for ammonia reduction in chicken manure remain limited, particularly at the laboratory scale, with clear comparisons to husks without biofilm [13]. Therefore, this study was conducted to evaluate the effectiveness of natural biofilm husks in reducing ammonia levels in chicken manure through an experimental approach comparing untreated and biofilm-treated husks. The results of this study are expected to provide a scientific basis for developing simple, sustainable technologies for managing chicken manure waste.

2. Methods

2.1. Materials and Equipment

The materials used in this study included fresh chicken manure obtained from broiler farms, rice husks, and distilled water. Rice husks were used as a treatment medium both in conditions without biofilm and after natural biofilm formation. The tools used included incubation containers, analytical scales, pH meters, and ammonia-analysis devices, in accordance with standard laboratory methods [14].

2.2. Selected Preparation of Natural Biofilm Rice Husk

Rice husks were washed with clean water to remove dirt and dust, then dried. Natural biofilm formation was achieved by incubating the husks in moist, open conditions at room temperature for several days, allowing biofilm to form through colonization by microorganisms from the surrounding environment [15]. Husk without incubation is used as a control (husk without biofilm).

2.3. Treatment Design

The study was conducted experimentally with two treatments, namely: (1) chicken manure treated with husk without biofilm as a control, and (2) chicken manure treated with natural biofilm husk. Each treatment was carried out using the same mass ratio of chicken manure to husks, and the resulting mixture was incubated under partially closed conditions to simulate livestock manure storage conditions [16].

2.4. Treatment and Incubation Procedures

Chicken manure was weighed as required and homogeneously mixed with husks according to the treatment. The mixture was then placed in an incubation container and left at room temperature for a specified period. During incubation, the physical condition of the manure was observed visually, including changes in odor and texture [17].

2.5. Ammonia Content Analysis

Ammonia content measurements are taken before treatment and after the incubation period using an ammonia analysis method in accordance with standard procedures. The measurement results are expressed in units of ammonia concentration and serve as the primary parameter for assessing treatment effectiveness [18].

2.6. Data Analysis

The percentage of ammonia reduction was calculated using the formula: (C0-Ct/C0)X100 %, where C0 is the initial ammonia level and Ct is the ammonia level after treatment. The measurement data were analyzed descriptively and presented in tabular form to compare the effectiveness of the unbiofilmed husk and natural biofilmed husk treatments [19].

3. Results And Discussion

In this study, chicken manure samples were collected from chicken coops that received two treatments: uncoated husks and naturally coated husks, as shown in Figure 1. The figure shows the condition of the chicken coop as the sampling location and the application of the two treatments used in this study.

The husk samples used in this study are shown in Figure 2, which displays the visual differences between uncoated husks and husks that have formed a natural biofilm. The presence of biofilm on the husks is indicated by changes in the husk surface, which appears more moist, and by the presence of a thin layer resulting from microbial colonization. These differences in husk conditions are related to differences in performance in reducing ammonia levels in chicken manure, as shown by the measurement results obtained.

Figure 1. Chicken coop using a base filled with rice husks (left), chicken coop with a base of rice husks with biofilm (right)

Figure 2. Rice husk samples with and without biofilm

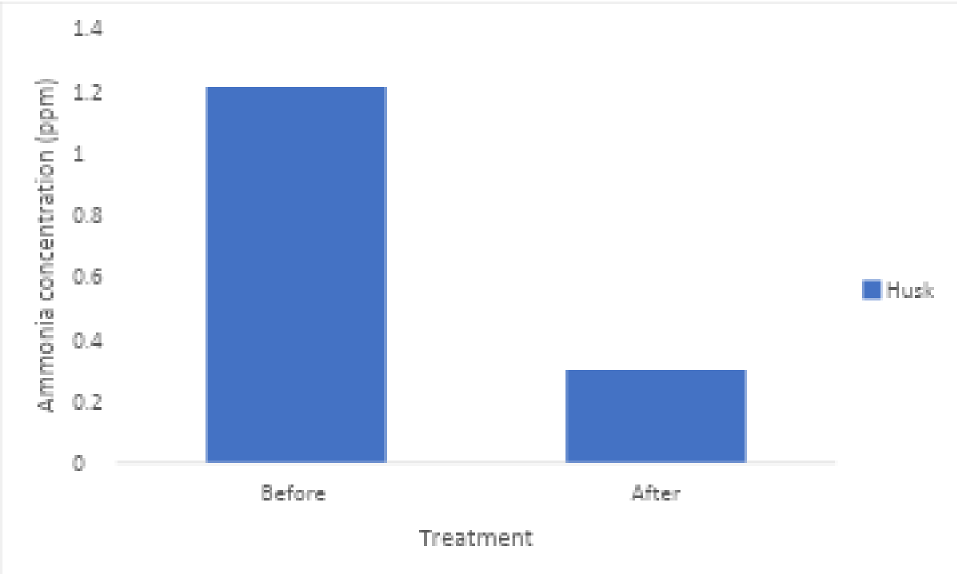

Figure 3. Ammonia concentration before and after natural biofilm treatment

Table 1. Ammonia Levels in Chicken Manure under Various Husk Treatments

Treatment	Initial Ammonia Level	Final Ammonia Level	Ammonia Reduction (%)
Uncoated husks (control)	1.21	1.21	0.00
Naturally coated husks	1.21	0.30	75.21

Measurements of ammonia levels in chicken manure showed a clear difference between the untreated husk (control) and naturally biofilmed husk treatments. In the control treatment, the initial and final ammonia levels were recorded at 1.21, indicating no reduction in ammonia during the incubation period [20]. This indicates that the use of husks without biofilm has not significantly suppressed the formation or release of ammonia from chicken manure.

In contrast, the natural biofilm husk treatment showed a significant decrease in ammonia levels. The initial ammonia level of 1.21 decreased to 0.30 after treatment, representing a 75.21% reduction [21]. This decrease indicates that the presence of natural biofilm on husks plays an important role in controlling ammonia, not just husks as physical material alone. These results are consistent with previous reports indicating that biofilm-based systems are more efficient at processing nitrogen compounds than inert media lacking biological activity [22].

The decrease in ammonia levels in the natural biofilm husk treatment is thought to be due to the activity of microorganisms forming biofilms on the husk surface. Biofilms provide a stable microenvironment for microbial communities, enabling nitrogen assimilation by heterotrophic microorganisms and ammonia oxidation by nitrifying bacteria [23]. This process causes ammonia to be bound within microbial biomass or converted into less volatile forms of nitrogen, thereby reducing the concentration of free ammonia [24].

In addition to bacteria, the presence of saprophytic fungi in natural biofilms is also thought to contribute to the reduction of ammonia. Fungi such as Aspergillus, Penicillium, and Trichoderma can utilize inorganic nitrogen to support biomass growth and cellular metabolism [25]. Fungal activity in biofilms also contributes to the decomposition of organic chicken manure, which can indirectly slow the rate of ammonia formation from organic nitrogen compounds [26].

A comparison between the control treatment and natural biofilm husks shows that biological mechanisms play a dominant role in ammonia reduction. Biofilm husks function not only as an adsorbent medium but also as a support for the formation of an active and sustainable biological system [27]. This approach has advantages over chemical methods because it is environmentally friendly, low-cost, and utilizes locally available materials [28].

Overall, the results of this study confirm that using natural biofilm husks is an effective strategy for reducing ammonia levels in chicken manure. With a reduction rate of more than 75%, this technology has the potential to serve as a simple and sustainable solution for chicken manure management, especially on small- to medium-scale farms [29].

4. Conclusion

Based on the study's results, the treatment of natural biofilm husks is effective at reducing ammonia levels in chicken manure. Ammonia levels decreased from 1.21 to 0.30, equivalent to a reduction of 75.21%.

5. Acknowledgement

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